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RESEARCH PAPER

Sustainability Attributes of a Small-Scale Betel Leaf Agroforestry System: A Case Study in North-eastern Hill Forests of Bangladesh

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Abstract The Khasia ethnic community of Bangladesh has been a population of forest villagers in the north-eastern hill forests of Bangladesh since the early 1950s, practicing a betel leaf-based agroforestry system on land granted by the Forest Department. Taking a sample forest village of the Sylhet forest division as a case study, this article examines the sustainability attributes of betel leaf production in the agroforestry system. The presence of several positive attributes of sustainability including the composition of agroforestry, disease control, soil fertility management, profitability, socio-cultural acceptability and institutional support indicate that betel leaf production within the agroforestry system is stable under the prevailing traditional management system. Income from the sale of betel leaf is the principal livelihood means and villager's reciprocal contributions help to conserve forest resources. However, problems with land ownership and regular agreement renewal need to be resolved for the sake of their livelihoods and forest conservation.

Keywords Forest villagers · Khasia community · Forest conservation · Land ownership

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Introduction

During the last three decades, various agroforestry systems have been promoted in developing countries as a means to increase household incomes and to generate environmental benefits that are well suited to poor farmers (Franzel et al. 2004). These systems contribute substantially to biodiversity conservation in a wide range of settings, such as in complex agroforests and swidden succession (McNeely 2004). In upland areas where the population increases rapidly, and deforestation and intensification of traditional cultivation (e.g. shifting cultivation) have reduced soil productivity, agroforestry can be considered a candidate alternative land use that might bring social, economic and ecological improvements to communities.

In the north-eastern hill forests of Bangladesh, the Khasia ethnic community has practiced their traditional betel leaf (*Piper betle* L.) agroforestry system since the early 1950s when they were settled as forest villagers by the Sylhet forest division. Settlement of forest villagers by the Forest Department (FD) was linked with forest reservation and expansion of plantations in Sylhet region. With the object of restoring the previous forest coverage, the FD initiated plantation programs in the 1920s (Forest Department 1970), and registered a few Khasia people as forest villagers in 1952–53. At present, there are six registered Khasia forest villages (or *punji*) in which villagers have been granted forest land for their house construction and agroforestry practices. The Khasia people supply their labour when and where needed for government plantations work. They maintain the plantations and protect the forest from pilferage.

It has been reported (Nath et al. 2003, Saha and Azam 2005) that this agroforestry system provides sustainable livelihood support to the forest villagers. However, these studies did not explore whether the present management is able to support villager's livelihood sustainably. Because villagers' livelihoods depend on betel leaf, this study has examined the sustainability attributes of betel leaf production within the overall agroforestry system that ensures the sustainable flow of income to villagers.

The betel leaf plant (*pan*), a perennial vine, is an important crop throughout Bangladesh and neighbouring countries. Usually people of South and South-east Asia, the Gulf States, and the Pacific islands chew it. In Bangladesh, the leaf is traditionally chewed with slices of betel nut (*Areca catechu* L.) and a thin coating of lime by all classes of people not only as a habit but also as an item of rituals, etiquette and manners. The leaf was exported in small quantities to India before 1954 (Rashid 1991). The leaf has medicinal values and is traditionally used for the treatment of various maladies, including bad breath, headache, ringworm and hysteria, and leaf oil possesses antibacterial, antiprotozoan and antifungal properties (Guha 2006). The economic significance of betel leaf in the past was such that Prince Azim-us-Shan, the *subhadar* of Bengal during 1697 to 1703, made it one of the royal monopolies calling it *Saudia khas*. Robert Clive, after the acquisition of the Mughal's provincial administrations in 1765, made betel leaf and betel nut a monopoly of the East India Company in 1767 (Banglapedia 2001). Presently, betel leaf is known as neglected green gold because it is one of the promising commercial

crops capable of generating substantial revenue for the Indian sub-continent including Bangladesh (Guha 2006).

Identifying the Characteristics of Agricultural Sustainability

The livelihoods of rural people depend on their village's natural capital (land, water, trees and forests), which provides all natural resources required by villagers (Komatsu et al. 2005), and hence resource sustainability has foremost importance to sustaining their livelihoods. Sustainable agriculture is a critical component of sustainable development. Although there are various definition of sustainable agriculture, there is a consensus on three basic features (Rasul and Thapa 2004; Zhen et al. 2005): (a) maintaining environmental quality (reasonable use of external inputs to prevent resource degradation and reduce risks of human health); (b) economic viability (ensuring stable and profitable production activities); and (c) socio-institutional acceptance (food security, technology adoption and effective institutional services including markets and policy). Sustainability requires that economic objectives be achieved while preserving the ecological and social systems that support humankind (Lamberton 2005). Dumanski et al. (1998) mentioned five pillars of sustainable land management, namely maintenance or enhancement of productivity and services, reduction of production risk, protection of the natural capital base, economic viability and social acceptability.

Potential criteria for assessing sustainability attributes of agroforestry include soil productivity and soil erosion control, addition of organic matter, improvement of physical properties, nitrogen fixation, improved nutrient cycling, and reclamation of degraded land (Nair 1993). Nair (1993) reported that quantitative measures of sustainability of agroforestry have not been developed yet and until such criteria and indices for assessment are fully developed and widely accepted, it will be necessary to rely on qualitative statements about the sustainability of agroforestry as is the case with other land-use systems. The International Tropical Timber Organization recently developed seven criteria, each criteria consisting of several indicators, of sustainable forest management (ITTO 2005). These criteria can be grouped into three major categories, namely enabling conditions (ITTO criterion 1), ecological criteria (ITTO criteria 2–6) and socioeconomic criteria (ITTO criterion 7).

In this study, the following criteria and indicators have been chosen as for investigating the sustainability attributes of the betel leaf agroforestry system:

- Ecological attributes: cropping patterns, species composition, pest and disease control, prevention of soil erosion and soil fertility management.
- Economic performance: trends of productivity, profitability, food security and savings.
- Socio-cultural and institutional aspects: people's beliefs on betel leaf agroforestry practices, self-sufficiency of inputs, and equity, policy on land rights, land ownership and markets. Input self-sufficiency means availability of local inputs, while equity means ability of the agroforestry system to generate employment opportunities for local people.

The Case Study

Prior to selecting the case study area, the authors visited all six Khasia forest villages and talked with villagers and forest officers about similarities and differences between the villages. Some differences were observed in village population size (which ranged about 20 and 40 households), house conditions in terms of building materials, literacy of household members and road communication to the villages. Forest conditions as well as characteristics of agroforestry plots were highly similar in all villages. Because there were no remarkable differences, it was decided to select one representative village.[1] Lawachara Khasia forest village, located inside the Lawachara National Park, and geographically between 24°30′–24°32′N and 91°37′–91°39′E, was selected purposively from among six forest villages.

Agroecologically the site belongs to the northern and eastern hills of Bangladesh, under the entisols soil order, and the general soil type is brown hill soil (Banglapedia 2001). Soil organic matter and fertility levels are generally low, and texture is generally sandy loam or silty loam. The area has a maritime climate characterized by high rainfall from April to September, and relatively dry weather from November to March. Humidity remains high at 70–85% throughout the year, and daily maximum temperatures remain above 30°C from April to October, and normally below 20°C from November to March (Saha and Azam 2005).

The Khasia ethnic community dominate in the greater Sylhet division along the north-eastern border of the country, the Khasia hills and the Shillong of the Meghaloya Plateau being the main residence of this tribe (Das 1999). Shillong, the capital of Meghalaya, is a mountainous area with an altitude of about 1500 m and covered with pine forest. The Khasia people are small to medium in stature and show a Mongoloid physique with a pale yellow complexion. The Khasia are partly animist and partly scheduled caste Hindu, the latter being rapidly Christianized (Rashid 1991). According to the 1991 population census the total number of Khasia in Bangladesh was 12,300 persons (Banglapedia 2001). Their major occupation is agriculture and betel leaf agroforestry is the dominant form of agriculture (Alam and Mohiuddin 1995). Other important products are lemons, pineapples and jackfruit.

Data Collection Method

Quantitative data were collected to assess the profitability of betel leaf production within the agroforestry system. Personal interviews were conducted of 21 of the 23 households in Lawachara Khasia forest village in May and June 2005, members of the other two households being unavailable at the time of interviews.[2]

A semi-structured questionnaire was developed, and was tested by interviewing five sample households in the study village, leading to some questions being deleted, and some new questions added. Written permission for interviews was

[1] Yin (2003) also suggested selecting one representative case study site if there are no remarkable differences among sites.

[2] Saha and Azam (2004, 2005) conducted studies in another Khasia forest village in Lawachara national park by sampling 20 households out of 40.

obtained from Sylhet forest division and a discussion was held with the village leader (*mantri*) before conducting household interviews. Without the *mantri*'s consent, villagers did not want to talk to interviewers. Interviews were conducted during May and June, 2005 in Bengali, a language the villagers could speak and understand well. One Khasia boy always accompanied the interviewers during household interviews but did not take part in interviews.

Profitability of betel leaf production was measured according to net annual income. To assess households' income, expenditures and savings, villagers were asked about their weekly income and expenditures for a list of items. It was observed that villagers could recall their weekly income and expenditures more accurately than monthly or yearly expenditure. For example, they recalled how much they spend for food in a week and how much they earn from betel leaf per week. Villagers said that even though expenditures may vary from week to week, this estimate gives a general picture of household expenditures. These figures were aggregated to an annual basis. The principal cost in betel leaf production within agroforestry is labour, and therefore villagers were asked how many male and female labourers they employ and for how many days in-season and off-season, and the annual expenditure on hired labour.

Descriptive statistics and correlation coefficients were estimated for variables concerning betel leaf production. Statistical inference was carried out considering the interviewed households of all six forest villages as a single sample.

Qualitative information was also gathered through a group discussion with villagers, informal talks with Khasia people of various ages and with forest officials, and through personal observations. Six men and two women were present in the group discussion, which highlighted views on the agroforestry system, management of soil fertility, pest and diseases control, markets for betel leaf, and problems relating to the agroforestry system. A separate semi-structured questionnaire was used to facilitate the discussion. Talks with forest officials dealt with policy on land rights, land ownership issues and participation of Khasia villagers in forest management activities. Khasia people talked about matters of concern to them, including living conditions and daily activities. Agroforestry plots were visited to identify species composition and observe soil conditions.

Study Findings and Interpretations

The Study Site and Agroforestry System

Topographically, the study site consists of many hillocks (*tila*) having an elevation of not more than 50 m, with moderate slopes. The forests of the Lawachara national park consist of mixed semi-evergreen old secondary regrowth. Almost 100-year-old plantations have created multistoried dense forest that looks like old growth forest. The most commonly visible plant species include *Tectona grandis*, *Artocarpus* spp., *Quercus* spp. and *Amorphophallus* spp. Commonly found wildlife includes *Hoolock hoolock*, *Macaca* spp. and *Trachypithecus* spp., as well as many bird

Table 1 Some basic characteristics of the case study forest village

Topographic feature: hilly topography with moderate slope
Road condition: earthen forest road
Distance to main road: 1 km
Distance to market: 9 km
Distance to nearest local government administration: 9 km
Distance to nearest medical facilities: 9 km
Electric power: not available
Source of lighting: kerosene and nine-volt batteries
Fuel source: wood
Drinking water source: ring well (major) and tube-well (minor)
Distance to government schools: 3–9 km
Total households: 23, with average household size of 5.62 persons
Literacy: 67% can read and write
House conditions: cement coating mud walled house with tin roof
Household appliances: almost all households possess television, cassette players or radio
Principal occupation: betel leaf based agroforestry

species. Some basic information of Lawachara Khasia forest village is reported in Table 1.

In the village, every household was allocated 1.01 ha for its agroforestry plot and 0.2 ha for the homestead, a total of 1.21 ha of granted secondary forest land. All households (23) were found to live together in a compound at the top of a hillock from which they could observe and walk to their agroforestry plots easily. After surveying, demarcation and fencing with bamboo sticks, villagers cleaned the agroforestry plots by slashing the shrubs and grasses and maintained the growing saplings and trees. When the growing trees attained at pole size (8–10 m in height), they planted 3–4 rooted cuttings of betel leaf, taken from 2 to 3 years old vines, near the base of each tree. It was observed that agroforestry plots have growing trees of different ages including saplings to more than 50 years old trees. Tree spacing was generally 2×2 m^2. Agroforestry plots were kept clean by manual weeding and partial sunlight filtering maintained by pruning the trees. Villagers were able to start plucking of betel leaf for sale 2 years after planting. They have an agreement with the FD not to fell the trees.

This agroforestry system differs from agroforestry systems implemented by the FD in other regions of Bangladesh, in which alley cropping with two or three fast growing tree species is practiced on degraded forest land. After 3–4 years, yield of agricultural crops (mainly rice) declines due to tree shade effects and farmers abandon rice growing and ultimately spaces between tree rows become unused. By contrast, in forest villages, villagers utilize existing plantations composed of many tree species for agroforestry practices and continue the system unless the plots are severely damaged by diseases or by natural calamity. The system of betel leaf production by Khasia people also differs from traditional betel leaf cultivation by plainland Bangladeshi people. Plainland people establish betel leaf garden (or

barouj) usually 0.01 ha in area, on areas elevated above the normal flood level enclosed by a wall of bamboo and reeds, and growing vines are twined around upright sticks of split bamboo and reeds (Banglapedia 2001).

Sustainability Attributes of the Agroforestry System

Ecological Attributes of Sustainability of the Agroforestry System

Though villagers prefer fluid-rich trees (e.g. *Artocarpus heterophyllus* and *Artocarpus chaplasha*, the bark of which produces latex), all trees in agroforestry plots are used as supporting trees. Thirty-six tree species were identified in agroforestry plots. If not affected by disease or damaged by cattle, every betel vine is satisfactorily productive for 10–15 years. However, within this period new cuttings are planted at the base of the support trees. Villagers dig a small hole for planting betel cuttings, which does not create any soil erosion. This practice makes it possible to maintain a range of ages of betel vines to ensure continuous production.

Two diseases are common, known as *uttram* and *uklam*, and occur mostly during the rainy season (June to August). *Uttram* damages leaves from the outside to the inside. The leaf edge becomes black, and the disease can spread through the whole plot within a week if precautions are not taken. Villagers generally cut off the affected branches, bury them far from the plots, wash all cloths and tools with hot water, and then take a bath so that the disease is not spread. *Uklam* causes root-rot and whole vines become yellowish. If preventative measures are not taken at the first sign of infection, the whole agroforestry plot may be damaged within 2 or 3 days. They uproot the affected vine, bury it far away, wash all materials, and take a bath. Villagers reported that burying of disease infected vines prevents spread of the disease. They also said that heavy damage due to disease occurs infrequently. During the study, two plots of two households with serious damage were observed. In very severe cases, villagers clear all vines, keep the plot vacant for 2–3 years, and then replant with cuttings. However, their long experience plus regular and intensive care prevent the outbreak of severe diseases. The Khasia observed that many Bengalis (the mainstream people of Bangladesh) tried betel leaf-based agroforestry, but their betel vines failed due to disease after 6 or 7 years. The Bengalis could not identify the diseases at the beginning even though they worked long hours in Khasia's agroforestry plots. The Khasia proudly feel that 'the betel leaf is given to us by God and only we can take care of it'. Due to its pungency, betel leaf is not vulnerable to attacks from vermin and insects (Banglapedia 2001).

The Khasia traditionally manage soil fertility by organic fertilizing with available plant materials. Every year, just before the monsoon season, they prune 80–90% of the branches from support trees, and allow them to dry out. When all the leaves have been shed, big branches are collected for fuelwood and the decayed leaves are spread uniformly at the bases of betel vines. Plots are weeded twice a year and the weeds are used as mulching. Mulching at the base of vines helps to hold moisture during the dry season. If mulching is insufficient, villagers collect weeds from the forest. They consider this humus enough to maintain soil fertility and have followed

this traditional agroforestry practice for more than 50 years on the same plots. Alam et al. (1993) also commented that Khasia people maintain soil productivity of betel leaf agroforestry plots through mulching and they do not use chemical fertilizer. During agroforestry plot visits, it was observed that the ground was covered with half-decomposed weeds, leaves and small branches. Topsoil was black, with high organic matter content. However, some people reported that because the forest had been declared a national park, collection of weeds was prohibited, hence some of them want to use chemical fertilizer in future. Villagers reported that two households applied chemical fertilizer, but they warned that this could increase the possibility of *uklam* as being experienced in other Khasia villages.

In summary, the agroforestry system accommodates many tree species and maintains regular age-gradations. Skilled people control diseases manually, keep up soil fertility through the use of organic matters, and minimum tillage does not create any soil erosion.

Economic Performance of the Agroforestry System

Two households (10%) who applied chemical fertilizer reported increasing yield, 17 households (80%) reported a constant level, and two households (whose agroforestry plots were affected by diseases) reported decreasing yield. This means that without using any chemical fertilizer and if there are no severe diseases, it is possible to achieve a constant level of production under present traditional management. The increasing trend of yield, however, does not mean that the households over-exploited the betel leaves, but they reported that due to application of chemical fertilizer leaf quality increased (e.g. bigger green leaf), attracting higher prices. Riadh (2007) observed similar trend in another Khasia forest village and reported that due to application of chemical fertilizer villager's income from betel leaf has increased.

To measure profitability, all costs incurred over the year prior to the survey (2004) and gross income from the sale of betel leaf was assessed as summarized in Table 2. The main cost involved with agroforestry is hired labour (*kamla*). Costs of chemical fertilizer (used by two households) and irrigation (used by *mantri*), and as well as household labour costs were not included in estimating mean input costs. Besides households labour, workers are employed, most of whom are females who carry out weeding and mulching. Male labourers carry out the physically demanding and specialized tasks, including pruning and plucking. A male–female wage disparity was noticed. Female's wages varied from Tk 25 to Tk 50 per day, whereas male's wages ranged between Tk 50 and Tk 80 per day. The lion's shares of costs are paid for male labour even though their working days are about half the hours of female labour.

Villagers divide the year into the in-season (May to August) and the off-season (September to January) based on rainfall. The number of days worked and labour costs of male and female vary between seasons (Table 2).

The main benefits (mean net annual income per household) come from the sale of betel leaf. The unit of productivity and selling of leaves is the *kuri*. Leaf productivity and prices vary between seasons. In-season leaf production per week per agroforestry plot is between 2.5 and 4 *kuri* and the price is between Tk 250 and

Table 2 Mean annual betel leaf production costs, outputs and income from betel leaf and expenditure situation of the villagers in the studied forest village

Variable	Mean level
Betel leaf production costs	
Labour working days and costs	
Male labour working days	112
In-season	49
Off-season	63
Female labour working days	217
In-season	94
Off-season	123
Costs for male labour (Tk)[a]	6245
In-season	2678
Off-season	3612
Costs for female labour (Tk)	6561
In-season	2832
Off season	3729
Mean input costs (Tk/household/year) [A]	12806
Agroforestry outputs	
Betel leaf productivity (*kuri*)[b]	
In-season	132
Off-season	118
Sale value (Tk)	
In-season	39683
Off-season	84331
Mean annual sale value (Tk/household/year) [B]	124014
Net mean annual income (Tk/household/year) [B–A]	111208
Mean annual expenditure[c] (Tk/household)	50107

[a] \$1 US = 65 Bangladeshi Taka (Tk), as of 2005

[b] 1 *kuri* = 2880 individual betel leaves

[c] Household expenditures include costs for food (more than 90% of total expenditure), healthcare, education, social work (religious festivals, prayer hall and village road repair), livestock rearing and hiring labour for forest patrolling

Tk 300 per *kuri*, while off-season productivity varies from one to three *kuri* per week, with price between Tk 650 and 700, and even more than Tk 1000 in February and March.

Correlation tests indicate that agroforestry income is related to agroforestry plot numbers[3] (Table 3 and Fig. 1). The reasons are that villagers could pluck leaves sustainably from a larger number of agroforestry plots. If diseases occur severely in an agroforestry plot, villagers can pluck leaves from other unaffected plots.0

Figure 1 summarizes the main correlation findings of Table 3. Among the variables, agroforestry income is more strongly correlated to off-season leaf production ($r = 0.90$) and off-season sale values ($r = 0.99$) than in-season production and sale values due to higher off-season demand (Fig. 1). Higher off-season sale values suggest that if villagers could irrigate their agroforestry plots

[3] Even though all households supposedly have only one agroforestry plot in this village, six households were found to have more than one agroforestry plot. Villagers said that some of them have expanded their holdings illegally, some purchased from others, and some inherited land from their kin (*Gousti* or extended patrilineal family members).

Table 3 Correlation matrix showing relationships among variables of betel leaf production in the agroforestry system of the studied Khasia forest village

Variables	AFI	AFN	HHM	MWD	FMD	MW	FW	SSV	OSSV	SPRO	OSPRO
AFN	0.67**										
HHM	0.21	0.57**									
MWD	−0.03	0.18	0.27								
FMD	0.56**	0.95**	0.56**	0.33							
MW	0.01	0.26	0.35	0.96**	0.38						
FW	0.49**	0.88**	0.51*	0.40	0.97**	0.43					
SSV	0.88**	0.68**	0.35	0.11	0.59**	0.17	0.52**				
OSSV	0.99**	0.63**	0.18	−0.07	0.49*	−0.04	0.43	0.81**			
SPRO	0.79**	0.69**	0.45*	0.18	0.64**	0.24	0.57**	0.97**	0.70**		
OSPRO	0.90**	0.67**	0.28	0.04	0.60**	0.06	0.53*	0.87**	0.87**	0.85**	
MINPUT	0.38	0.72**	0.67**	0.77**	0.80**	0.84**	0.80**	0.48*	0.31	0.54*	0.41

AFI mean annual income from agroforestry, *AFN* agroforestry plot number, *HHM* household member, *MWD* male labour working days, *FMD* female labour working days, *MW* male labour wage, *FW* female labour wage, *SSV* in-season sale value, *OSSV* off-season sale value, *SPRO* in-season production, *OSPRO* off-season production, *MINPUT* mean input costs

Significant difference at $^{**}P < 0.01$ level and $^{*}P < 0.05$ level

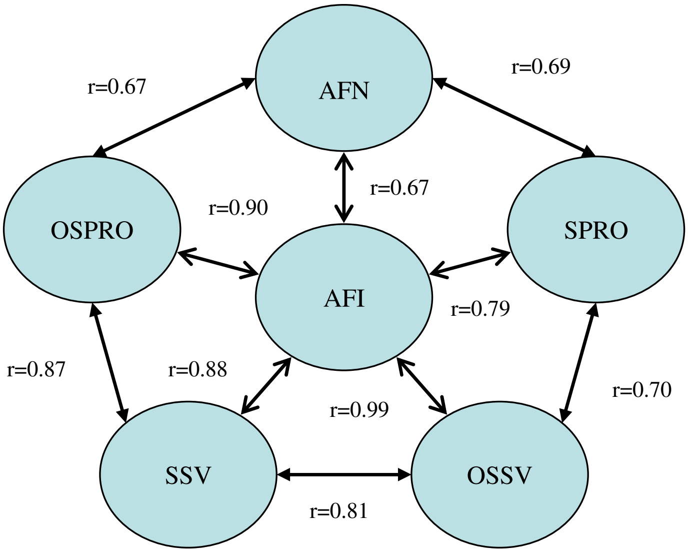

Fig. 1 Correlations among some important variables of betel leaf production in the studied agroforestry system practiced by the Khasia forest villagers

during the dry seasons, they could expand the plucking period and increase their income. In this regard, they could arrange collective irrigation systems. During the study, researchers observed that there is a perennial stream just beside the village. Villagers could collectively make a temporary earthen dam (for the dry season, November to March) to create a reservoir for irrigating their agroforestry plots with a shallow water pump connected to long pipe. A shallow pump would cost no more than Tk 5000, and could be used for many years. It was noticed that the *mantri* has a deep tube well by which he irrigates his agroforestry plots in February and March and hence obtains a higher price (even Tk 1300 per *kuri*). After March, all leaves become yellow and shed.

Villagers were asked about their food security status using a three-level scale: surplus, sufficient and shortage. All households said that the income they obtain from agroforestry (Table 2) is sufficient to cover the costs of food and other necessities. Mean annual income of Khasia villagers (Tk 111208) is about three times as high as per capita national income of Bangladesh, which was Tk 35904 in 2006–07 (Statistical Year Book Bangladesh 2007). Saha and Azam (2004) drawing data from another forest village reported that average income of Khasia forest villagers was seven times as higher as national average income of Bangladesh.

After covering all production and household expenditures, villagers have a saveable surplus, but did not reveal the amount or what they do with their savings. However, forest officers and some villagers reported that almost all households invest their savings in acquiring more agroforestry plots in other non-registered Khasia villages. These additional plots ensure them steady incomes in case of disease infestation in plots in the study village. Extended family members or

relatives care for these plots, which the extended family members visit occasionally for maintenance. Alam et al. (1993) also reported that some Khasia villagers can save a substantial portion of their betel leaf income that they invest for purchasing or establishing new agroforestry plots.

Socio-Cultural and Institutional Aspects of the Agroforestry System

Khasia forest villagers have been practicing this agroforestry generation after generation. The *mantri* stated that ‘Betel leaf is our blood, our life. All of our culture and festivals are based on this leaf. We are the only people who can grow this betel leaf ‘.

This statement expresses how deeply the agroforestry system is rooted in their lives. They learned this land-use technology from their forefathers and still keep up this practice. However, they refine the management system through interactions with neighbours and relatives. For example, the two households which applied chemical fertilizers for the first time in their agroforestry plots were inspired by their relatives who live in nearby forest villages.

Khasia believe the agroforestry plots are sacred places. Every morning they bathe before entering the plots and wear clothes used exclusively for agroforestry activities. They feel hurt if outsiders enter a plot without bathing because this could introduce plant diseases. Their beliefs and culture are strongly connected with agroforestry. They believe that burying ashes of dead bodies increases productivity of betel leaf because the soul of dead enters the crop field and fertility increases. They also believe that the dead body would have connection with betel leaf and hence the priest recites at the funeral ‘Good bye, good bye. You will chew betel leaf in the kingdom of God’ (Banglapedia 2001). Walker (2004) also mentioned that upland agriculture is intrinsically linked by locally specific belief systems and cultural practices. Traditional culture, which is embedded in human knowledge and experience within religious faith and which is deeply rooted in the minds and hearts of small-scale farmers, makes agriculture meaningful and sustainable (Alhamidi et al. 2003).

Villagers reported that the agroforestry management activities including weeding, support tree pruning and betel leaf plucking depend, to a large extent, on the local labour force and locally available plant materials for soil fertility management. Local landless and marginal people are employed to perform these activities. It was found that on average over 1 year 112 male days and 217 female days were employed in the village (Table 2). Some households employ labourers all year. Moreover, some people obtain employment during marketing of products. Five middlemen (*paikar*) come 3 days a week to purchase betel leaves from the village and employ six to eight male labourers each day to transport the produce to the main road. Hence, it seems that the agroforestry system is input self-sufficient and has an equity effect in generating local employment. Moreover, villagers reported that many people are engaged with marketing of the leaves to various regions of the country and local administrations earn revenue.

Due to possession of multiple agroforestry plots by some households, there are income disparities among the villagers. However, they said that wealth differences have created a small extent of social stratification which does not induce any

conflicts. They have trust in neighbours and in forest officers and obtain help from each other when needed. In addition to social works (e.g. repair of prayer hall, wells and village road) villagers help each other in agroforestry tasks. For example, if any household needs weeding on its agroforestry plots, it sometimes requests some villagers to help, and for this the household arranges a feast for the villagers who help.

Related to institutional aspects, the FD initially granted land to the villagers on a renewal basis for 99 years. They will enjoy inheritable land rights, but cannot sell or even shift from allotted and demarcated land. Renewal is done for the same area of land allotted to each household. In accordance with policy administered by the FD, the agreement between the FD and the forest villagers is to be renewed every 2 years. The *mantri* informed that the agreement was last renewed in 1982. When the local forest officer was asked about the renewal status of the agreement, he replied that he sent all the papers for renewal to the divisional office last year (2004). But another senior officer said that since 1982 there has been no activity to renew the agreement. The villagers wonder what might happen if the FD does not renew their agreement. It is significant that though they have been living in the village since the early 1950s, they still do not have legal land ownership status and are appealing for permanent land ownership. They believe that if they would have permanent land ownership, then they would not think about renewal of agreement. However, FD officers suspect that if they provide permanent land title, the villager would not abide by the agreement. It was noticed that there were no real conflicts between villagers and FD over land ownership. However, due to lack of regular renewal of agreement and lack of regular monitoring of the granted land, some villagers extended their agroforestry plots boundaries illegally. The FD needs to ensure, after monitoring the status of granted land, at least regular renewal of the agreement so that villagers know they have land security and this could check the illegal occupation of land by some villagers.

Betel leaf has a huge domestic market. As well, villagers reported that high quality leaves from their agroforestry are being exported to the United Kingdom. Many people from Sylhet division live in the United Kingdom and they are the main consumers of these leaves. As there are internal as well as significant foreign markets for the product of this agroforestry system, future markets appear assured.

Usually women deal with selling of betel leaf in the villages. They negotiate prices with the *paikar*. When they feel that the *paikar* offer unacceptably low prices, then they call on the *mantri* who then talks with leaders of other Khasia villages by his mobile phone to coordinate the supply price.

Livelihood Strategies of the Villagers

The livelihood strategies pursued by the Khasia people included mainly agricultural intensification and limited livelihood diversification. This study reveals that all their efforts are concentrated on agroforestry system, which use low-capital inputs (local labour, organic fertilizer) and generate high returns through betel leaf production. Some households cultivate pineapples and lemons in agroforestry plots, but these are for household consumption, not to sell. Because betel leaves generate enough

cash to meet the household demand, villagers are not interested in growing other crops (Alam et al. 1993). A few households have livestock and one girl works for an NGO that operates education, credit, savings, legal awareness and leadership development program in the village. However, villagers utilize forest resources in meeting most of their household food demands. They purchase rice, fish, meat, spices, oil, snacks, confectionary and tea from markets but collect most of the vegetables from forests. They informed that more than 80% of their vegetables-including arum, jackfruit, various tubers and green leaves, and mushrooms- are collected from forests and their maximum dietary requirements are fulfilled from forest resources. Therefore, livelihood strategies indicate that betel leaf, the main product of agroforestry system, is the key element to their living.

Concluding Comments and Policy Implications

A number of positive attributes of sustainability are present at the studied betel leaf agroforestry system that the Khasia forest villagers have practiced for half a century. Even though the biophysical environment of the agroforestry was not investigated, for example in terms of soil nutrients, and a comprehensive financial analysis was carried out, it is apparent from the case study that the system still performs well under prevailing traditional management. There is no incidence of land degradation. Income from betel leaf production supports villagers' livings, and their reciprocal contribution to plantation activities and day-night patrolling of forests help to conserve forest resources (Nath and Inoue 2008). Even though the system alters the forest conditions by regular weeding and pruning on agroforestry plots, it conserves tree diversity. However, to provide greater assurance of the villagers' livelihoods and avoid possible conflicts between the FD and forest villagers, land ownership issues needs to be resolved with mutual understandings and negotiations. The FD could then recover the encroached land by re-demarcating the boundary of granted land. As this studied village is located inside a national park, the recovered land could be placed under a co-management scheme.

It is increasingly argued that conservation areas and buffer zone management today have come to rely on user groups based in settlements located close to or within protected area boundaries (Agrawal and Gupta 2005). Though the Lawachara national park was created 10 years ago, it neither involves villagers in its management, nor has a buffer zone from which they can collect wood for household use. These lands could be buffer zones in which they could grow fuel wood, and grass for AF plots. This would reduce pressure on park resources. Even though villagers claim that they meet fuel wood demand from their AF plots, field observations show that the branches from pruning are not enough to provide fuel to cook three meals a day. The important point is that villagers need to be motivated and convinced, and be given a sound understanding of their participation in co-management. Policy regarding benefit sharing and the level of participation need to be clearly formulated based on negotiations with villagers and FD.

This study has potential policy implications. It has found that many community-based forestry projects in Bangladesh have failed, mainly due to inappropriate

technology and lack of institutional support, after their project periods expired (Roy 1998). If projects are able to identify the comparative advantages unique to each geographical area based on its social, ecological and economic characteristics, and to provide the necessary institutional support, it is likely that projects will be successful even after project period expiration. If villagers can realize sustainable benefits, they will find it in their own interests to maintain the production system whether it is forestry, agricultural, or any other kind of development intervention. The study indicates that because forest villagers realize continuous benefits from the agroforestry system, they expend resources on conserving their agroforestry plots as well as the government's forests.

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